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Second Bimonthly Report

on the

Miniature IF Amplifier Program

25X1

Period: 1-Sept.-1959 to 1-Nov.-1959

25X1

Prepared by:

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I Purpose

See Bimonthly Report No. 1.

II Abstract

The amplifier suitable for use in a single conversion receiver will make use of a miniature crystal filter. Being the heart of the amplifier, work on this part of the program is currently confined to fabrication of the crystal filter. An account of this work, which is being undertaken for the [redacted] 25X1 25X1 is included in this report.

The second amplifier, suitable for use in a double conversion receiver, makes use of ceramic resonators for selectivity and interstage coupling. This report includes an account of the various measurements made on several different ceramic transformers with respect to temperature stability of the bandwidth and center frequency as well as the insertion loss and loading effects.

III Factual Data

(a) Crystal Filter Program

Crystals were fabricated which permitted the assembly of a two section half-lattice filter. The center frequency of this filter was 2.297742 Mc/s. The frequency spacing of the first two pairs of crystals was somewhat less than desired for the final filter. The bandwidth was, consequently, limited to 3.231 kc. Crystals are currently being fabricated for the final design.

The characteristics of the crystals used in the construction of the first section of the filter were inferior to those used in completing the filter. The spurious response of the second group of crystals was controlled more effectively than was the case for the first group. As a result of this, no firm evaluation of the spurious response of the complete filter has been made. The measured insertion loss of the filter was less than 2 db and the passband ripple of the complete assembly was 0.3 db.

Stray capacities within the filter are fairly critical. The filter will incorporate two trimmer capacitors in order to compensate for stray capacitance. Adjustment will be made through holes in the filter case with the holes being sealed after initial alignment. External capacities have less effect on the filter response than was originally expected.

The components of the filter are being assembled on four printed circuit wafers in a modular fashion. The shape factor which gives the most promise of satisfactory filter performance has dimensions of 0.75 x 0.75 x 2 inches or a volume of 1.125 cubic inches. An effort will be made to reduce this volume to one cubic inch.

(b) Ceramic Resonator Program

A small sample of improved ceramic resonators have been evaluated in a passive test circuit (Figure 1) and in a two stage transistor amplifier (Figure 2).

Resonators 1, 2 and 3 were fabricated from one variety of ceramic material produced while resonators 4 and 5 were fabricated from a second type.

The variation of center frequency with temperature is shown in Figure 3. The deviation of the center frequency over the temperature range of -40° to $+40^{\circ}$C from the room temperature value is +3.7 kc, and -1.0 kc respectively for samples 1 to 3. Samples 4 and 5 had an average deviation of +0.7 kc and -0.2 kc over the same temperature range.

The bandwidth characteristics are shown in Figure 4. Resonators 1, 2 and 3 had a bandwidth deviation of -0.88 kc and +0.33 kc over the temperature range while resonators 4 and 5 had a deviation of -1.09 kc and +0.37 kc. The mean room temperature bandwidths were 11.33 kc and 10.83 kc for the two different materials.

The insertion loss characteristics are shown in Figure 5 and in Table 1.

Sample No.	R_{in}	C_{in}	Insertion Loss
	ohms	$\mu\mu f$	db
1	22 kΩ	44	-2.41
2	20 kΩ	50	-2.22
3	19 kΩ	44	-1.88
4	7.4 kΩ	33	-1.76
5	8.8 kΩ	40	-1.49

Table 1. Input Impedance and Insertion Loss Characteristics of Ceramic Resonators.

The use of ceramic resonators as interstage coupling transformers will result in problems of output loading by the input capacitance of the succeeding stage. Figure 6 shows the variation of bandwidth as the load capacitance is varied from 0 to 120 $\mu\mu f$. It is seen that the load capacitance should be kept to a minimum in order to achieve as wide a bandwidth as possible.

Resonators 4 and 5 were inserted into a two stage amplifier (Figure 2). An overall bandwidth of 7.37 kc at a center frequency of 456.3 kc was obtained. The power gain was 46.7 db with a measured input impedance of 3000 ohms. It was noted that the bandwidth was to some extent dependent upon the input signal level, being narrower for low signal operation.

IV Conclusions

Due to the significance of stray capacitances in the determination of the overall characteristics of the crystal filter it appears that it will be necessary to have two preset trimmers included in the filter package, for compensation purposes. These trimmers are, naturally, space consuming. As a result the present configuration occupies 12.5% more volume than originally intended. Efforts will be made to meet the specifications by a slight rearrangement of the other components of the filter.

Ceramic transformers are now being fabricated which exhibit desirable temperature and bandwidth characteristics. The insertion loss is quite low. The major problem at this point of the program is that of capacitive loading at the output of the transformer as a result of the subsequent transistor. If necessary a capacitive divider network may be used. Although requiring an additional capacitor in each stage it is possible that a secondary benefit could be derived in the form of improved interstage impedance matching--the maximum ratio which is realizable in practice with a ceramic transformer being somewhat less than that desirable for transistors.

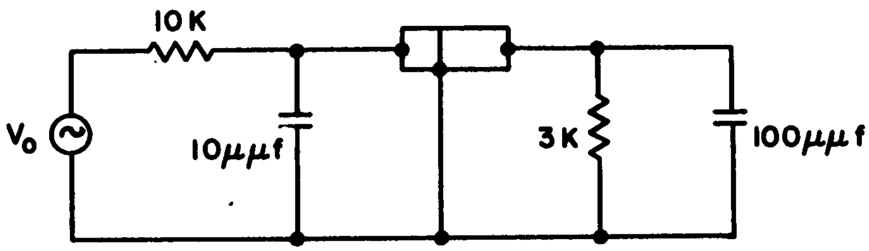
V Future Plans

As soon as a preliminary version of the crystal filter has been completed it will be sent to [redacted] where work will commence 25X1
on the associated amplifier stages. It is intended that the preliminary filter resemble the final version as far as electrical characteristics are concerned with the possible exception of the exact center frequency. It will thus be possible to proceed with the circuit design while the final filter is being packaged.

An effort will be made to obtain the maximum gain per stage from the amplifier suitable for use in a double conversion receiver. While the amplifier is being designed, the lumped ceramic filter will be constructed. A complete test can then be made of the low IF amplifier.

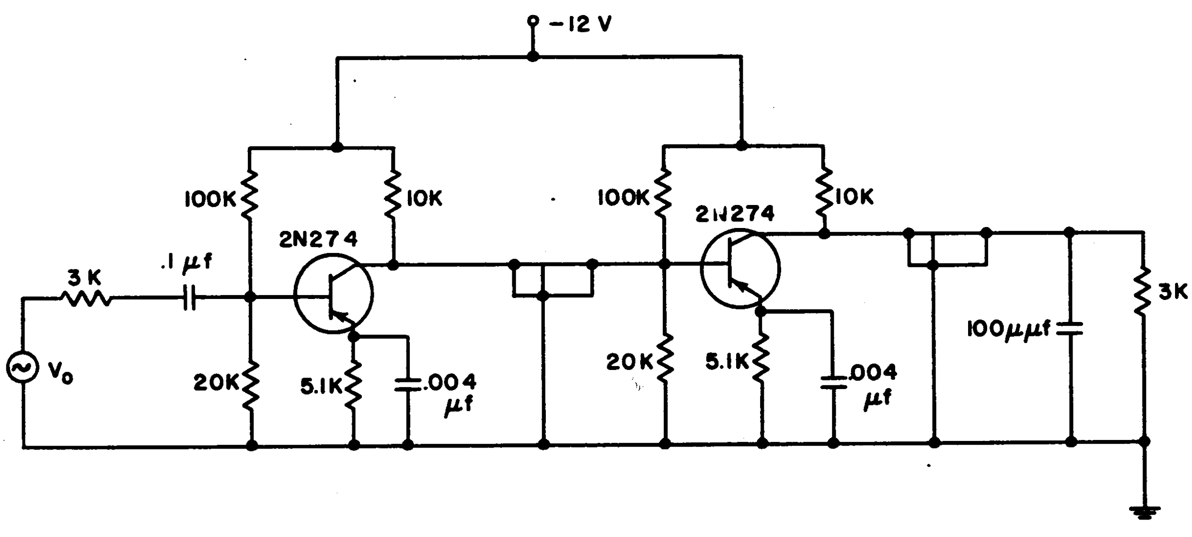
VI Identification of Key Technical Personnel

See Bimonthly Report No. 1.



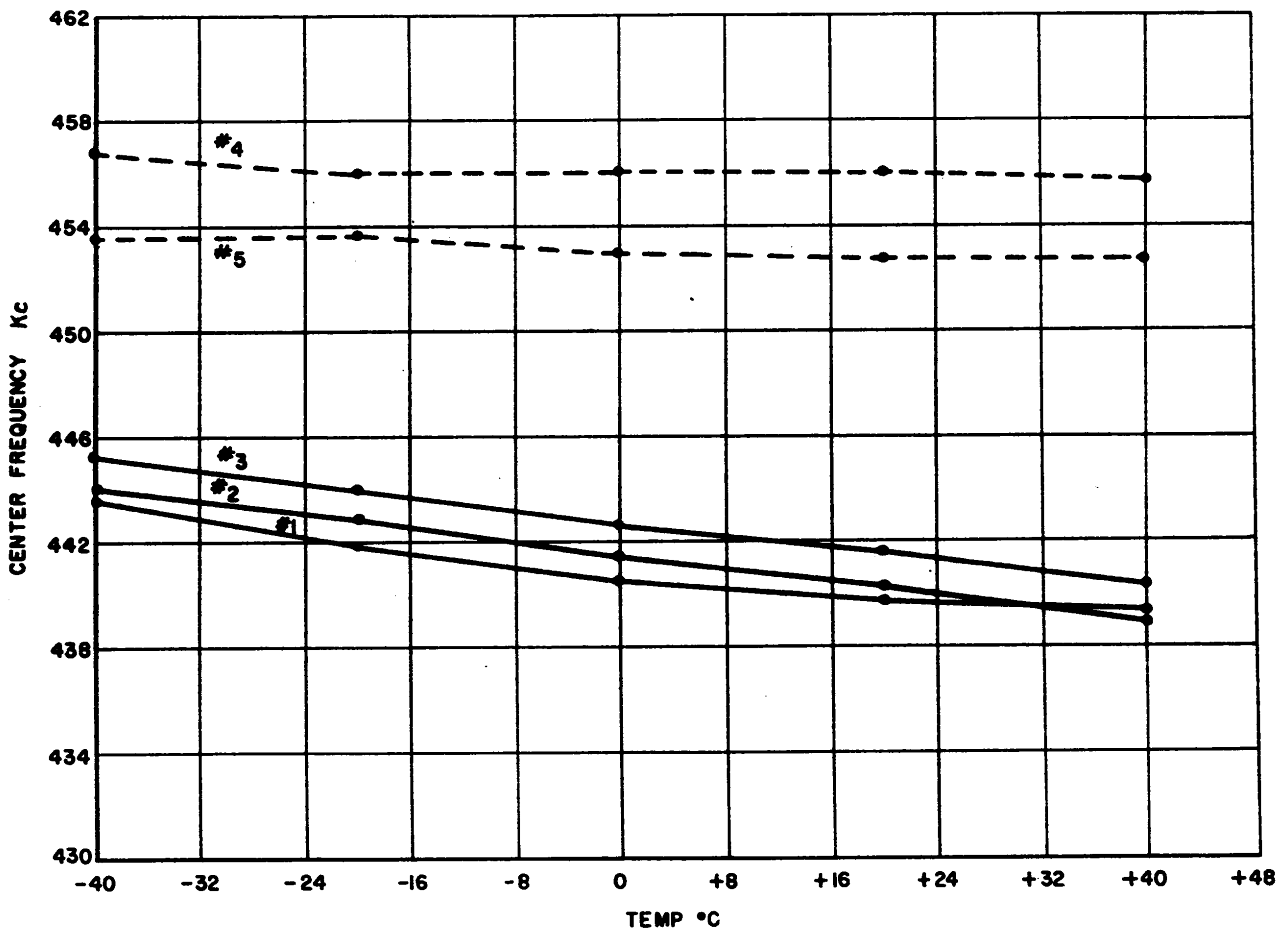
CERAMIC RESONATOR TEST CIRCUIT

FIGURE I



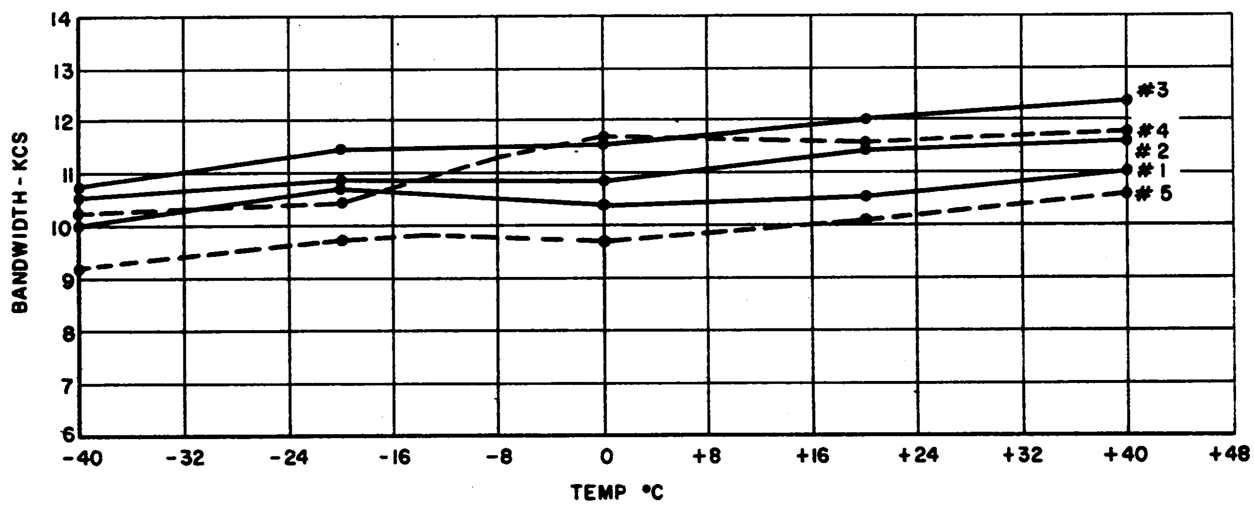
TWO STAGE CERAMIC RESONATOR AMPLIFIER

FIGURE 2



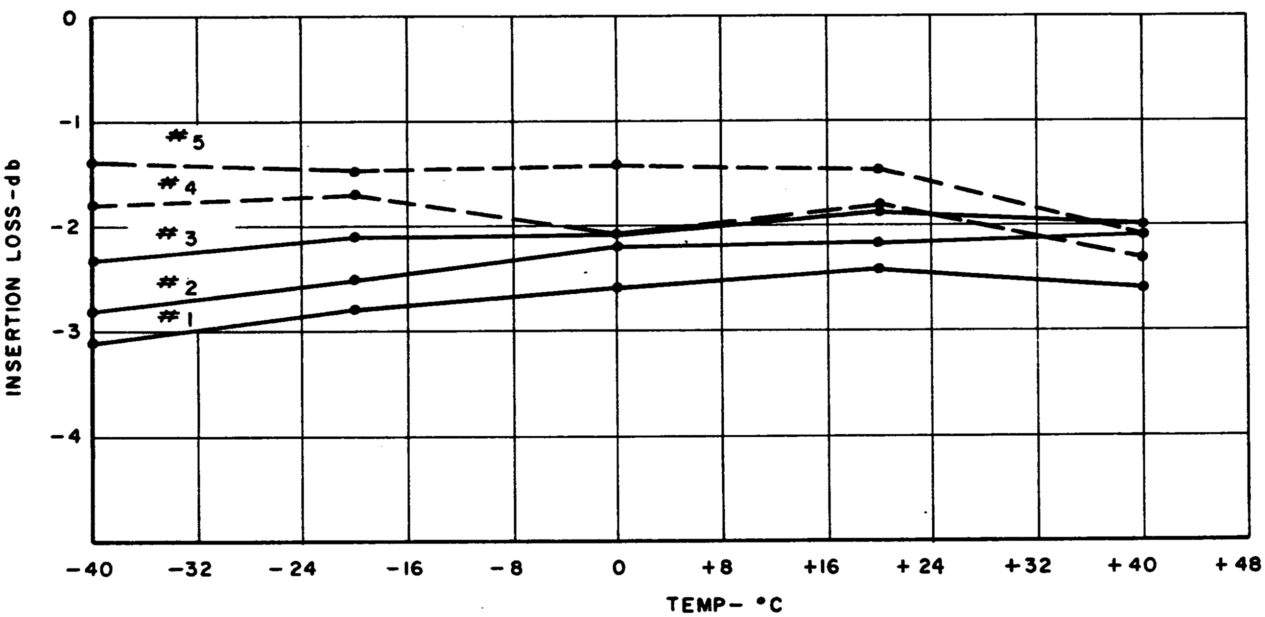
CENTER FREQUENCY VARIATIONS OF CERAMIC RESONATORS

FIGURE 3



BANDWIDTH VARIATIONS OF CERAMIC RESONATORS

FIGURE 4



INSERTION LOSS CHARACTERISTICS OF CERAMIC RESONATORS

FIGURE 5

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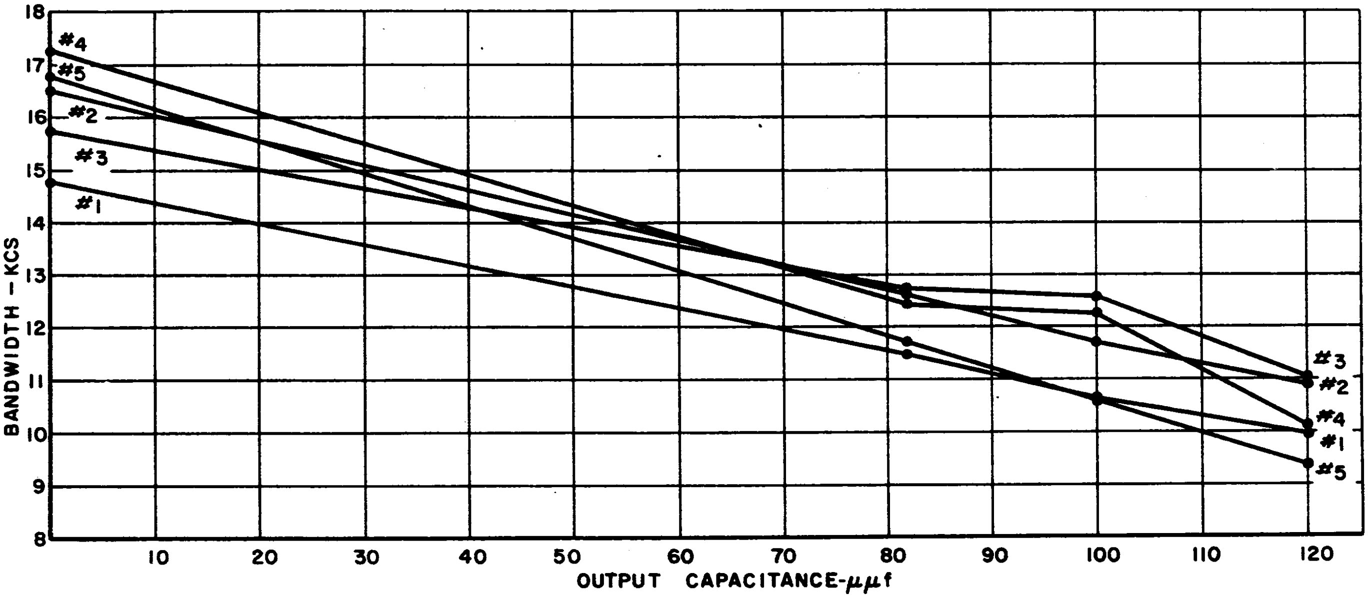

BANDWIDTH AS A FUNCTION OF OUTPUT LOADING

FIGURE 6